

**Title:** Modeling and Simulation Verification, Validation & Accreditation (VV&A) ----  
A New Undertaking for the Exploration Systems Mission Directorate

**Author:** Mr. Mark E. Prill, MSFC, ESMD Integrated Modeling and Simulation Office

**Format:** Powerpoint presentation to JANNAF Conference Attendees

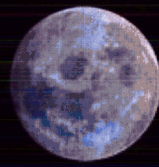
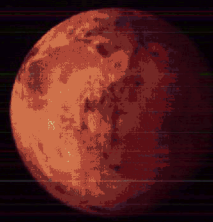
**Date of Presentation:** 13 June 2005

**Content:**

The overall presentation was focused to provide, for the Verification, Validation, and Accreditation (VV&A) session audience, a snapshot review of the Exploration Space Mission Directorate's (ESMD) investigation into implementation of a modeling and simulation (M&S) VV&A program. The presentation provides some legacy ESMD reference material, including information on the then-current organizational structure, and M&S (Simulation Based Acquisition (SBA)) focus contained therein, to provide a context for the proposed M&S VV&A approach. This reference material briefly highlights the SBA goals and objectives, and outlines FY05 M&S development and implementation consistent with the Subjective Assessment, Constructive Assessment, Operator-in-the-Loop Assessment, Hardware-in-the-Loop Assessment, and In Service Operations Assessment M&S construct, the NASA Exploration Information Ontology Model (NExIOM) data model, and integration with the Windchill-based Integrated Collaborative Environment (ICE). The presentation then addresses the ESMD team's initial conclusions regarding an M&S VV&A program, summarizes the general VV&A implementation approach anticipated, and outlines some of the recognized VV&A program challenges, all within a broader context of the overarching Integrated Modeling and Simulation (IM&S) environment at both the ESMD and Agency (NASA) levels. The presentation concludes with a status on the current M&S organization's progress to date relative to the recommended IM&S implementation activity.



# exploration



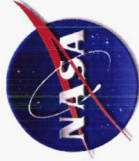
...the essence of the human spirit.

*Frank Borman*

APOLLO ASTRONAUT







***Modeling and Simulation  
Verification, Validation & Accreditation (VV&A)  
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A New Undertaking for the Exploration Systems  
Mission Directorate***

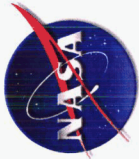
***Presented to the JANNAF Conference***

***June 13<sup>nd</sup>, 2005***

***Mr. Mark Prill***

***Exploration Systems Mission Directorate***



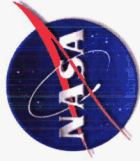


# **Agenda**



- 1. Some Background Reference Material Regarding the Exploration Space Mission Directorate (ESMD)**
- 2. A Brief “Legacy” Organizational Perspective**
- 3. The Simulation Based Acquisition (SBA) Point of Departure for ESMD Integrated Modeling and Simulation**
- 4. The Current VV&A Implementation Status within the ESMD**
- 5. Some Recognized Issues and Challenges Ahead**



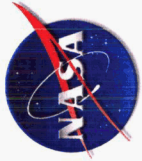


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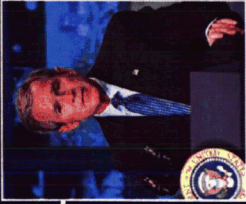
# 2004 President's Vision for Space Exploration A New Future for U.S. Civil Space Programs



"This cause of exploration and discovery is not an option we choose; it is a desire written in the human heart."  
President George W. Bush  
February 4, 2003

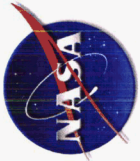
"We leave as we came, and God willing as we shall return, with peace and hope for all mankind."  
Eugene Cernan (Commander of last Apollo mission)  
December 17, 1972

"... America will make those words come true."  
President George W. Bush  
January 14, 2004



- On January 14, 2004, President Bush articulated a new Vision for Space Exploration in the 21st Century
- This Vision encompasses a broad range of human and robotic missions, including the Moon, Mars and destinations beyond
- It establishes clear goals and objectives, but sets equally clear budgetary 'boundaries' by stating firm priorities and tough choices
- It also establishes as policy the goals of pursuing commercial and international collaboration in realizing the new vision
- **Advances in Human and Robotic Technology will play a key role as enabler and major benefit of the new Vision...**





## Key Elements of the Nation's Vision

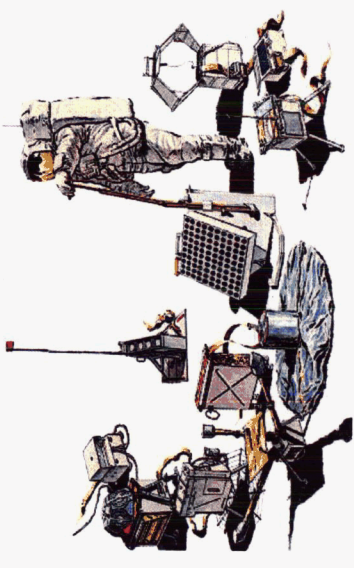


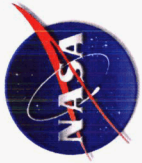
- Objectives

- Implement a sustained and affordable human and robotic program
- Extend human presence across the solar system and beyond
- Develop supporting innovative technologies, knowledge, and infrastructures
- Promote international and commercial participation in exploration

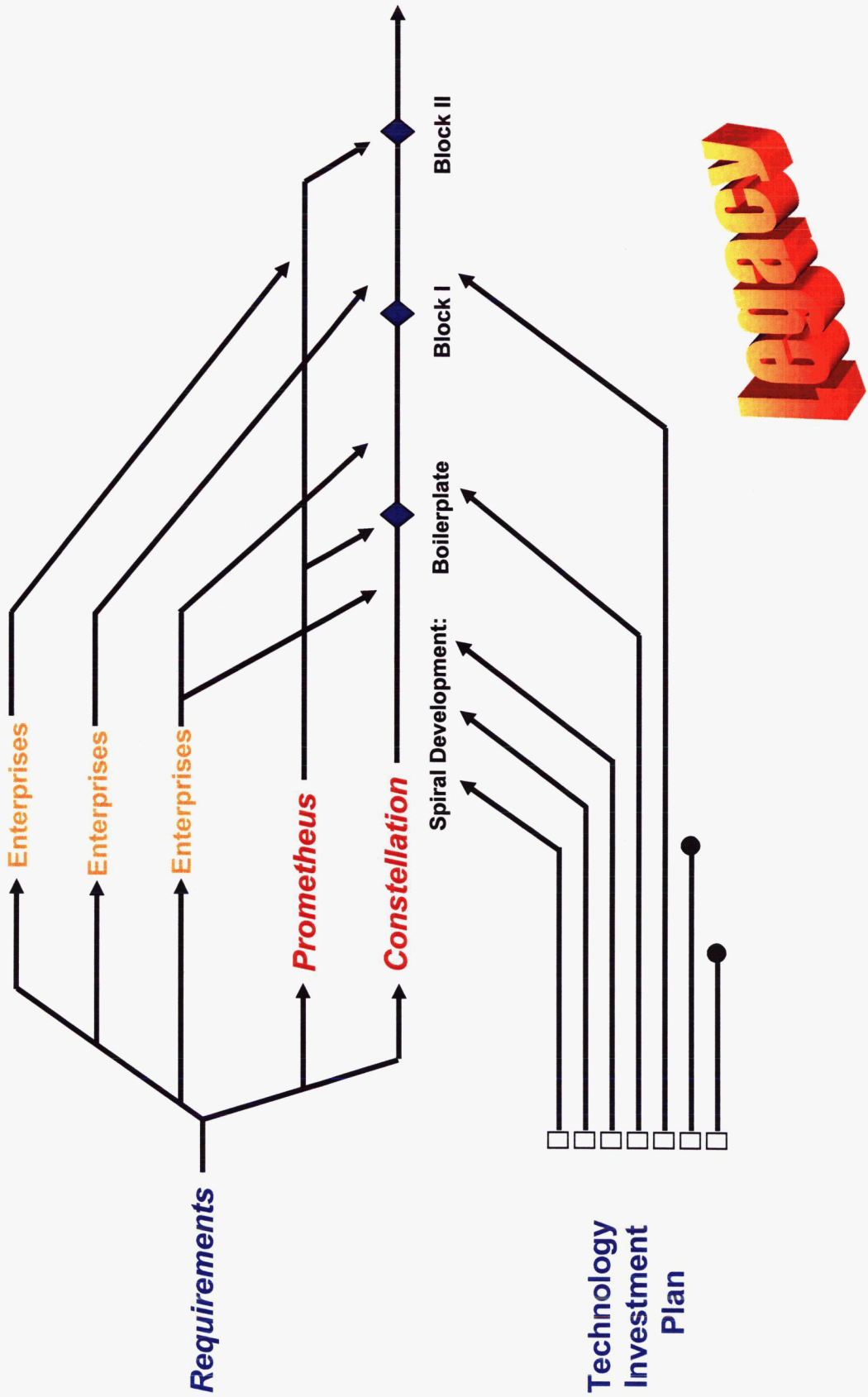
- Major Milestones

- 2008: Initial flight test of CEV
- 2008: Launch first lunar robotic orbiter
- 2011 First Unmanned CEV flight
- 2014: First crewed CEV flight
- 2015: Jupiter Icy Moon Orbiter (JIMO)/Prometheus
- 2015-2020: First human mission to the Moon





# Requirements and Technology Investment Flow







The diagram illustrates the timeline of the Indian Space Program, showing milestones and phases from 2004 to 2020.

**Milestones:**

- Pre MS A (BAA) JUN 04**
- MS A Concept Refinement JAN 05**
- MS B Program Initiation TBD**
- MS C Unmanned CEV Flight 2011**

**Phases:**

- Down Select**
- System Development & Demonstration**
- System Development & Integration**

**Target** (Moon)

**2015 (Objective)**

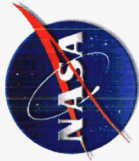
**2020 (Threshold)**

**Legacy**

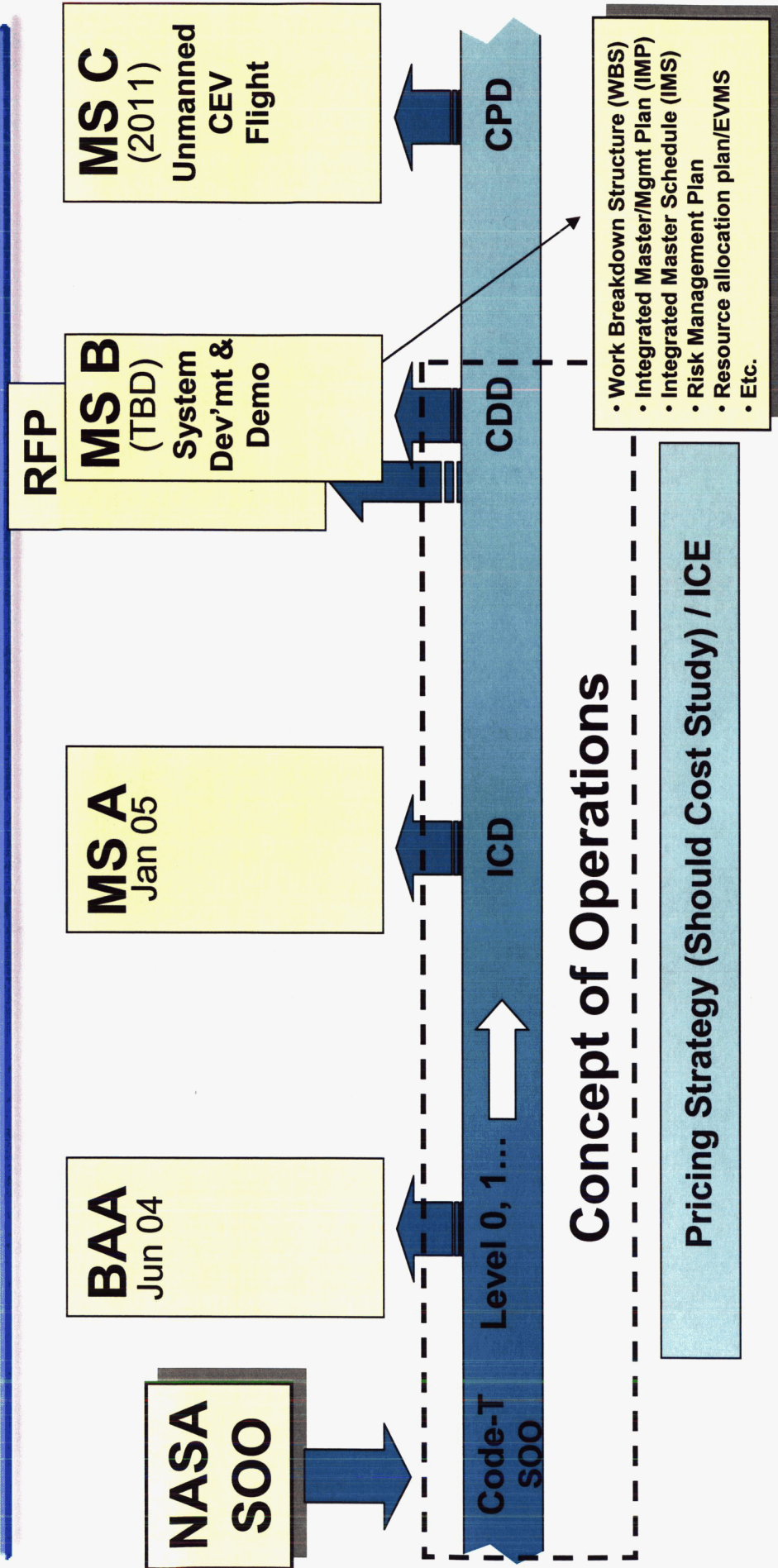
## Milestones:

- 2015 Jupiter Icy Moon Orbiter (JIMO)
- 2015 Prometheus Demo



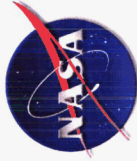


# CEV Spiral Development Roadmap



CEV: Crew Exploration Vehicle  
SOO: Statement of Objectives  
BAA: Broad Agency Announcement  
MS: Milestone  
ICD: Initial Capabilities Document  
CDD: Capability Development Document  
CPD: Capability Production Document

**Legacy**



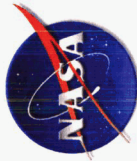
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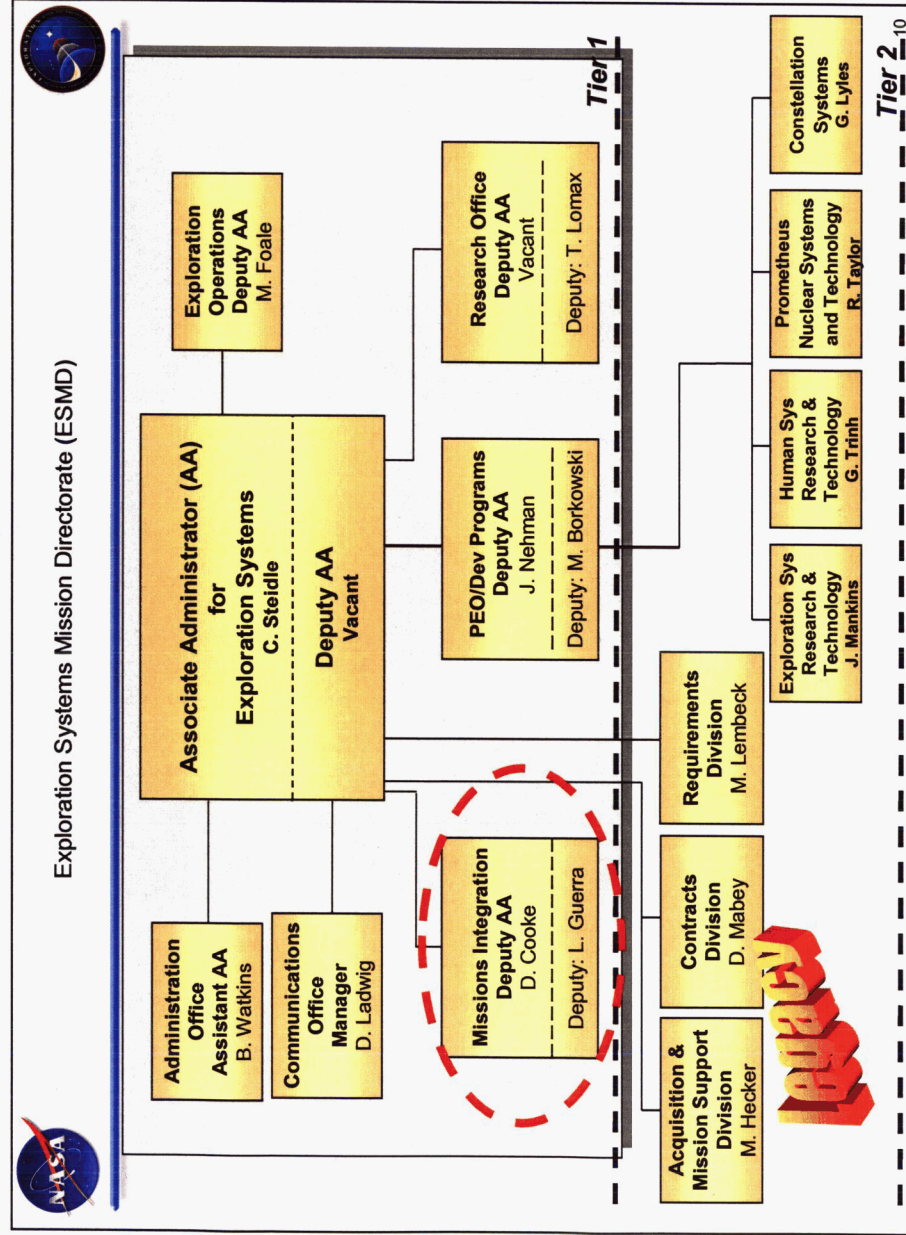


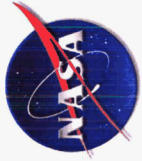


# Simulation Based Acquisition (SBA) Status – 5-16-2005



The Chief Information Office (CIO) and the Simulation Based Acquisition (SBA) Support Office were merged into one entity Collaboration, Modeling and Simulation Office (CM&SO) in the ESMD Systems Integration Division



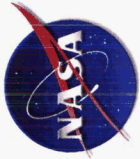


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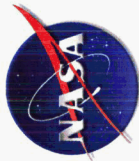


## **Exploration Systems Mission Directorate Vision “A Simulation Based Acquisition (SBA) Culture”**

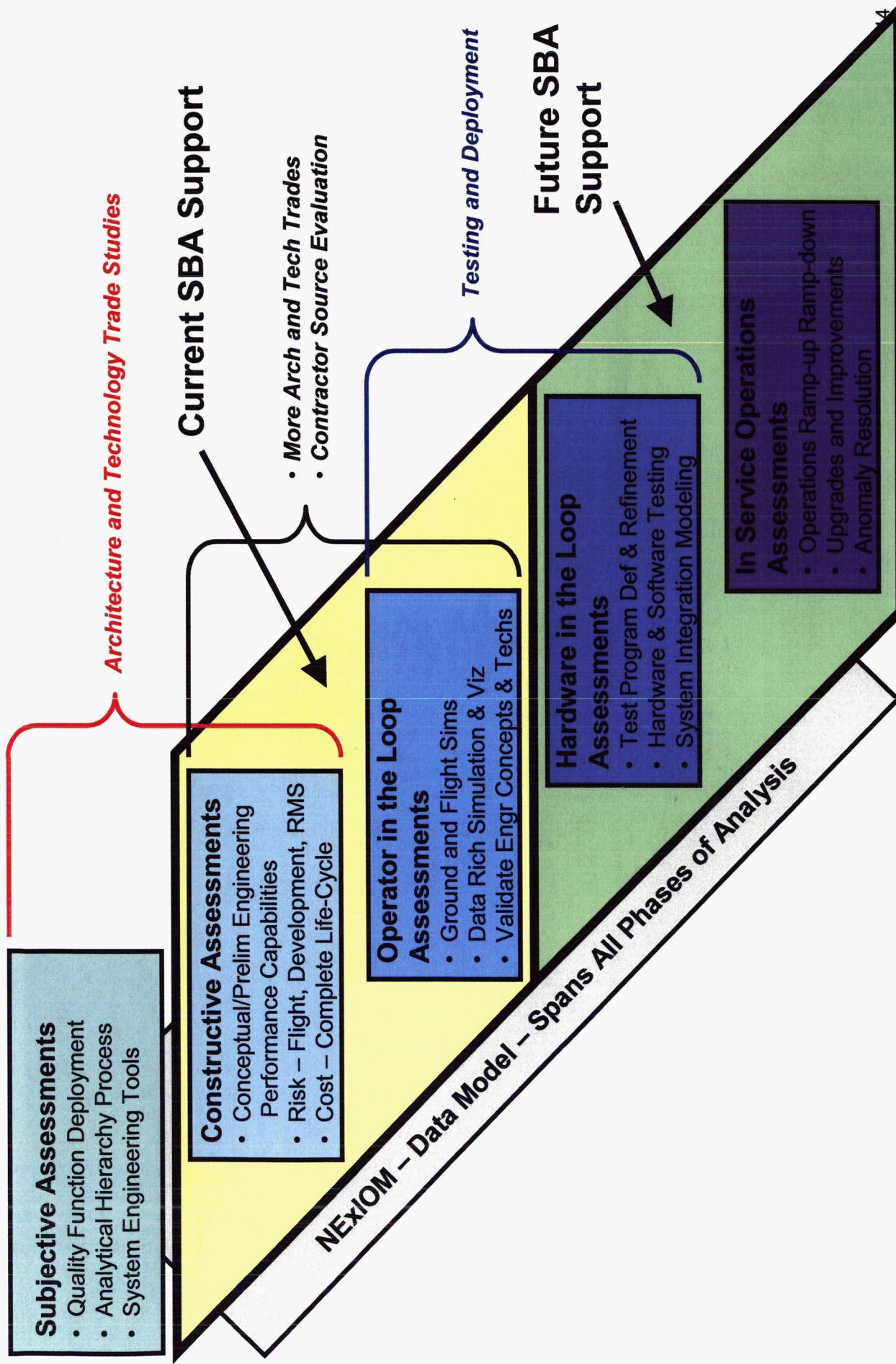


- **SBA Goals:**
  - Enable better informed, timelier and more defensible decisions throughout the acquisition life cycle.
  - Speed the design and development, and improve the quality of acquired systems at less cost and risk than would otherwise be the case.
- **SBA Objectives:**
  - Educate (SBA Orientation) and foster pervasive SBA capabilities through the ESMD organization
  - Provide early and continuous system life cycle viewpoint with modeling and simulation of products and processes
    - Requirements analysis and concept formulation, through design, development, manufacture, test, training, and operations
  - Large trade space investigation through use of Modeling and Simulation (M&S)
    - A robust tool kit of validated modeling and simulation capabilities
  - Single, authoritative source of analytical data for all organizations

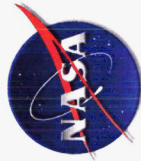




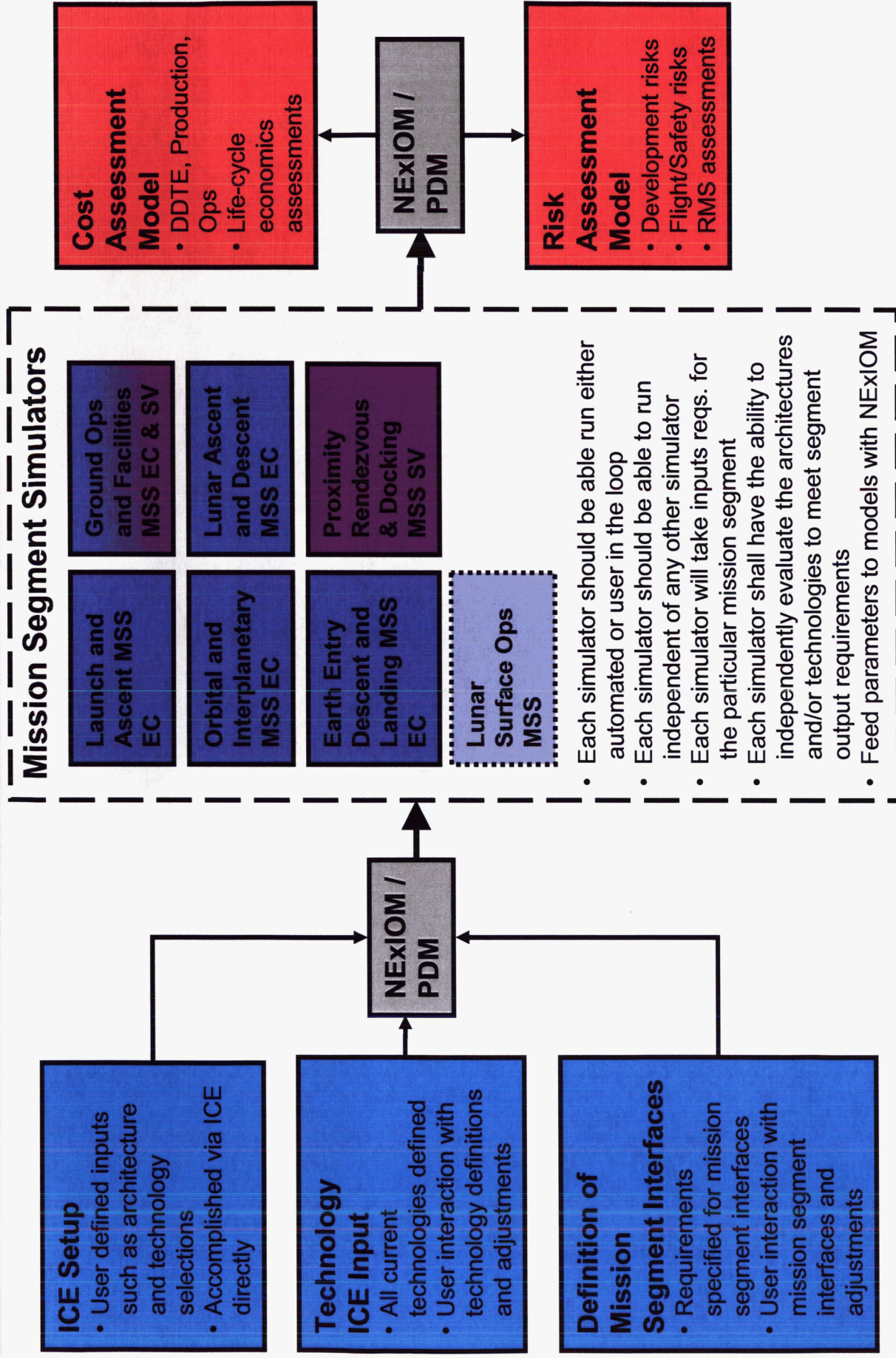
# SBA Future Roadmap



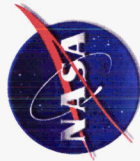




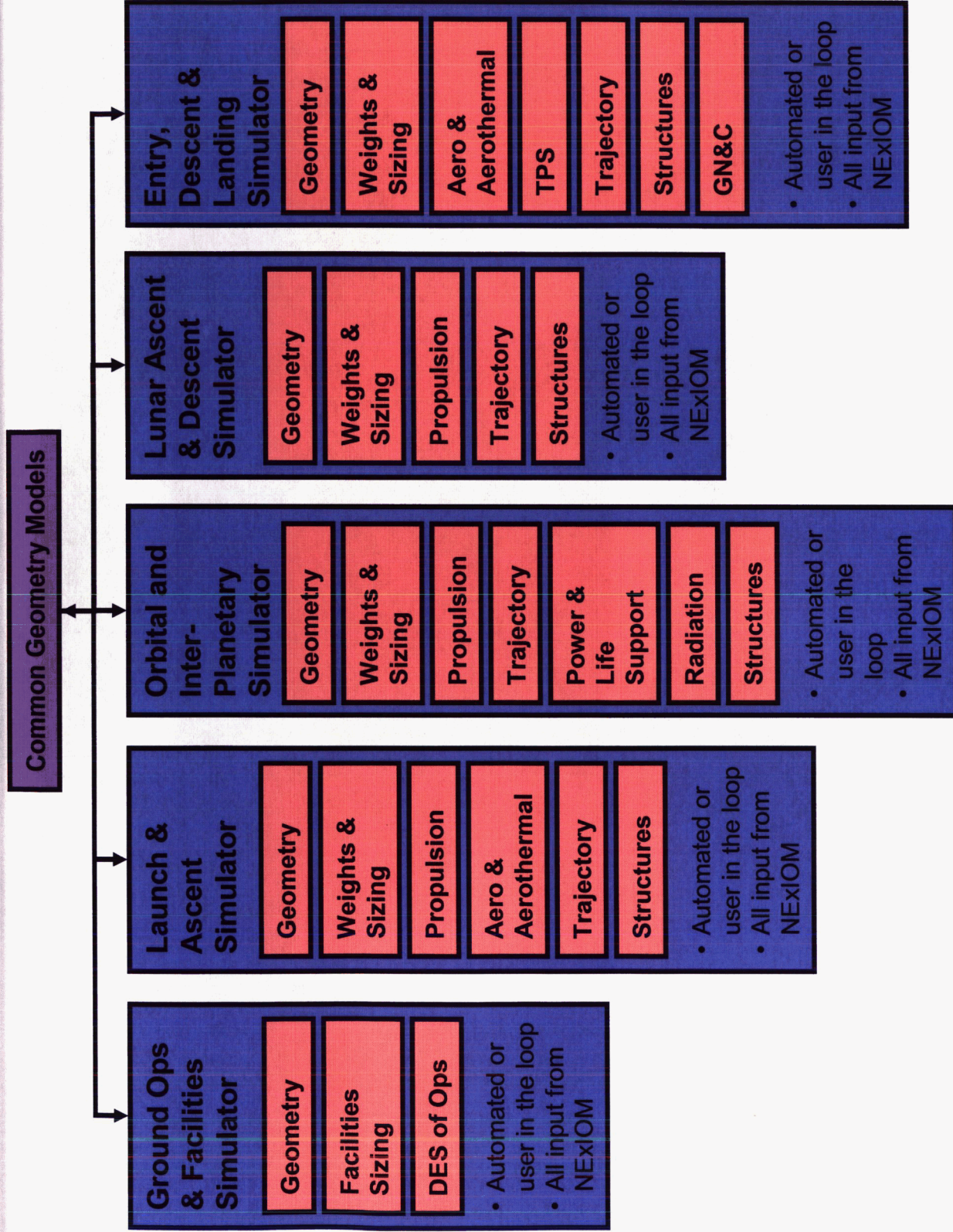
# Step C – Comprehensive initial capability for September '05

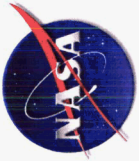




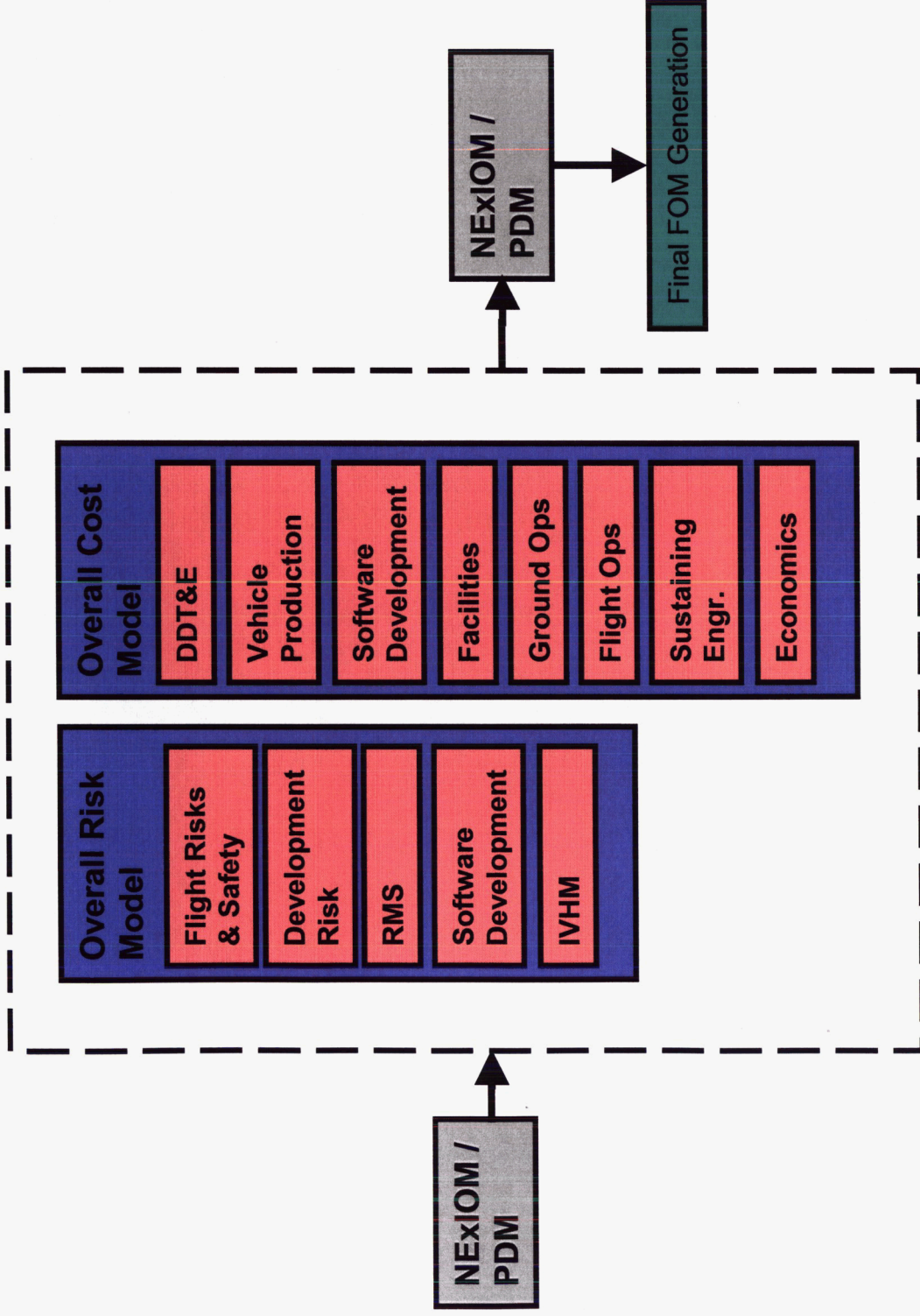


# Step C – Comprehensive initial capability for September '05

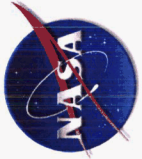




# Step C – Comprehensive initial capability for September '05







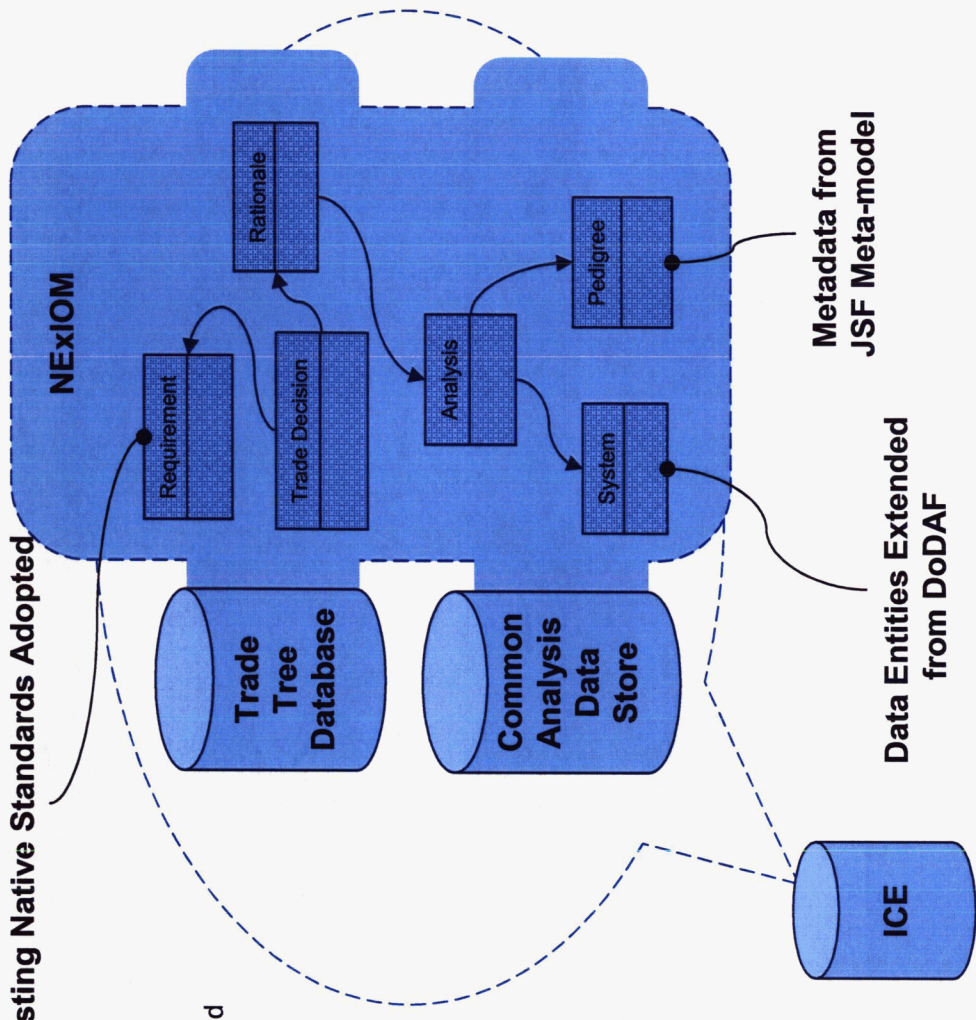
# NExIOM Represents / Relates Information Resources



**NExIOM itself consists of meta-data, formatted data resources, synopses of acceptable formats and mappings amongst them.**

## Three Pillars of NExIOM:

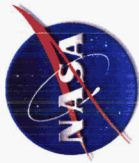
- **Decision Traceability:**
  - Understanding of Lineage, Quality and Use Constraints
  - Defensibility of Rationale
  - Locate-ability of Responsible Parties and Supporting Analyses
- **Analytical Consistency**
  - Authoritative Data Locations
  - Data Dictionary
  - Common formats, ground-rules, applicability, units and definitions
- **Data Access, Understanding and Management**
  - Human exploration of data and information through browsing, querying, visualization and inference
  - Machine support for human understanding



**NASA and Industry Utilize NExIOM standards to exchange information.**

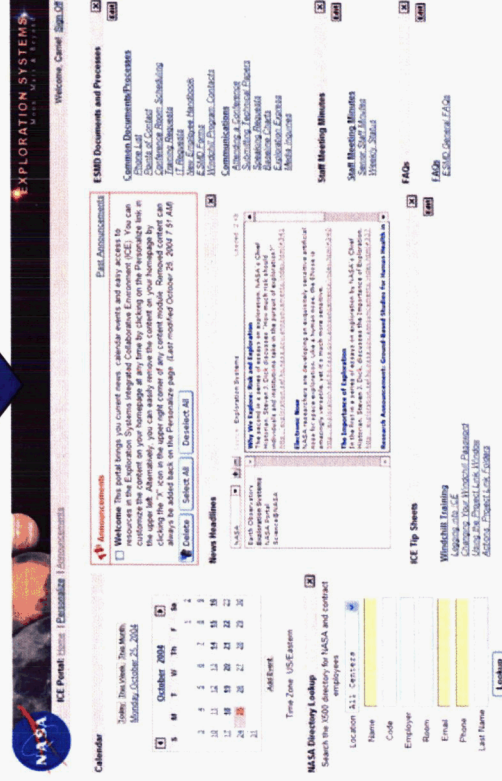
**The CEV RFP mandates NExIOM described deliverables.**





# Integrated Collaborative Environment

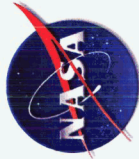
ICE is web-centric environment which will be used by industry, academia and government for: sharing, collaborating, integrating, accessing and controlling management information and product data defining all of the products which are part of Exploration Systems.



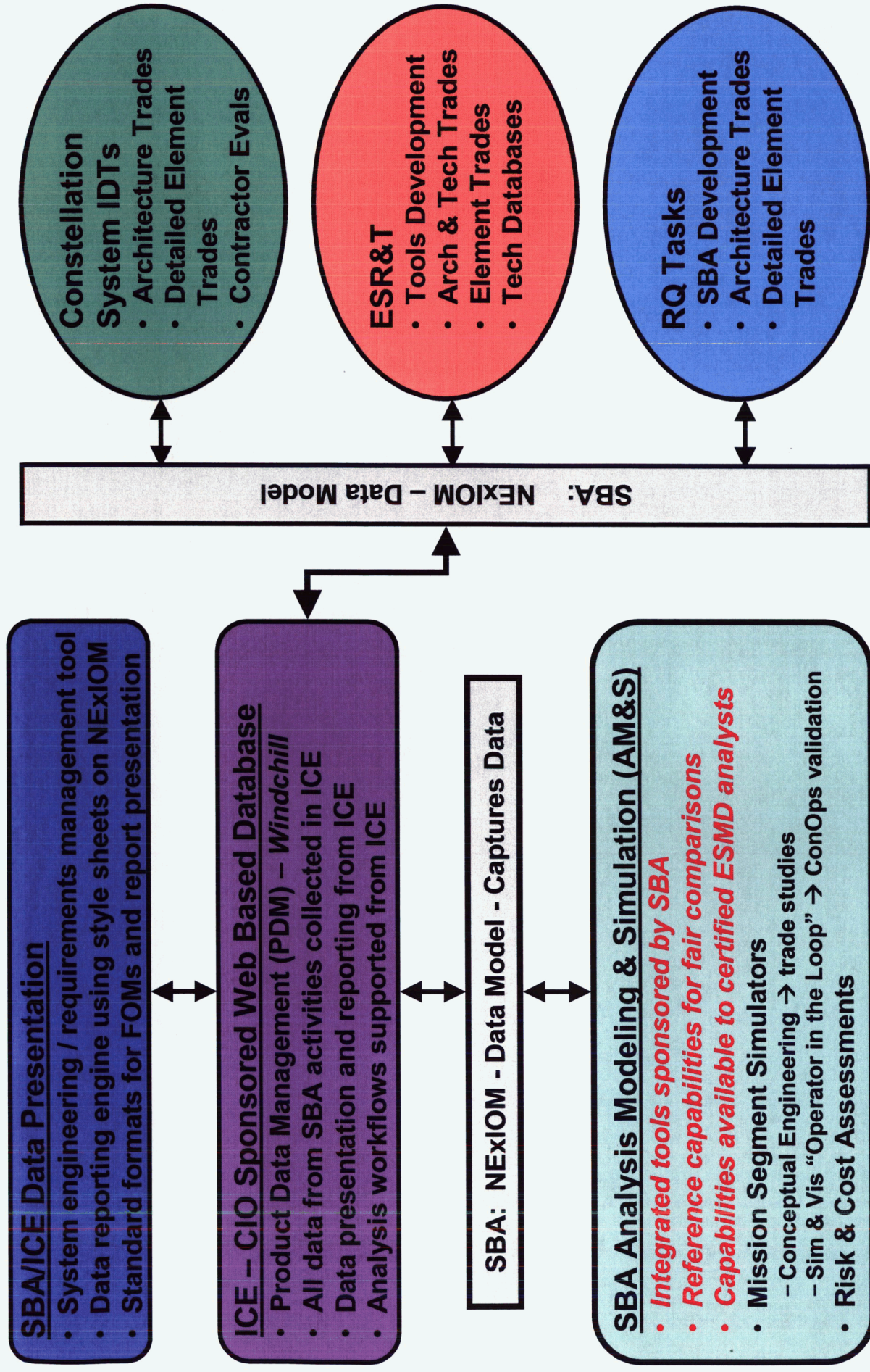
- Single source access to all ESMD data
- Integrated programmatic
- Accessibility from anywhere in the world

**ICE is the authoritative source for all program data**

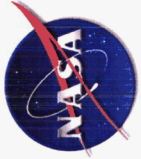




# Data Structure Relationships of SBA



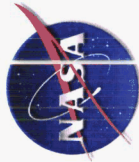




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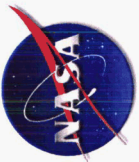
## ***Mr. Cooke's 2 June VV&A Briefing Purpose***



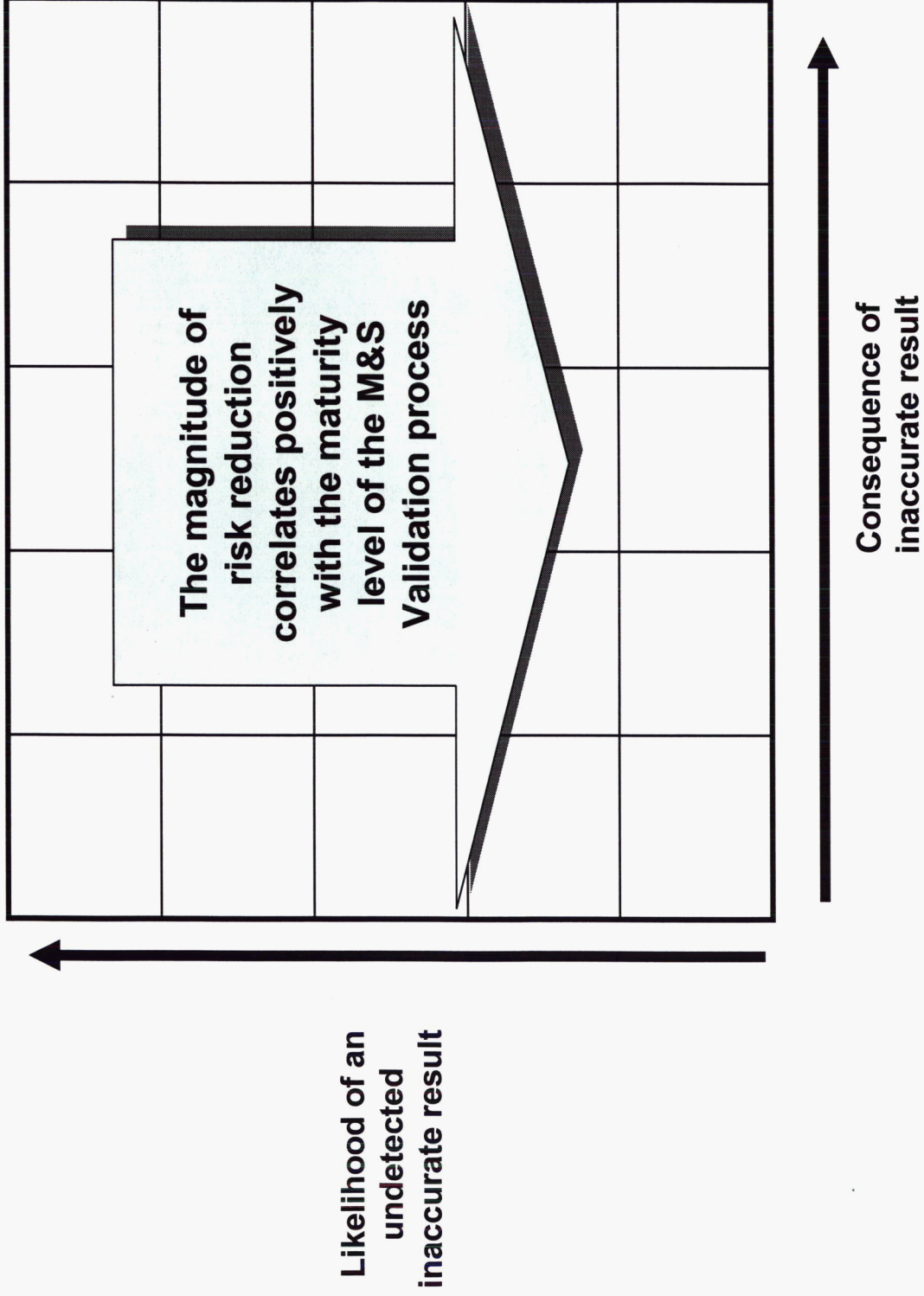
**This briefing is intended to address three things:**

- 1. provide relevant information pertaining to the proposed Verification, Validation and Accreditation (VV&A) approach for the ESMD's Systems Engineering and Integration (SE&I) integrated Modeling and Simulation (M&S) capabilities**
- 2. broach a recommended ESMD VV&A Policy Statement**
- 3. act as a request for a formal venue in which to get ESMD senior leadership concurrence on:**
  - the recommended VV&A Policy and the associated implementation plan, and/or**
  - corrective guidance as to how to proceed**

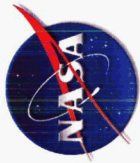




# VV&A Enables Reduction in Program Risk



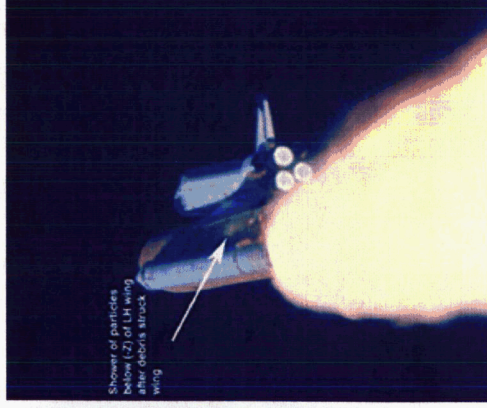




# User Impact – Space Shuttle Columbia (Engineering application)



Debris forward of LH wing leading edge



Shower of particles below (L2) of LH wing after debris struck wing

“Engineering analysis (involving the Crater simulation) conducted during the flight concluded for NASA managers that although the foam might have caused some structural damage to the wing area, it would not have been sufficient to cause a catastrophic event.” *R. Dittmore, Columbia mission manager, February 3, 2003*

“We have found the smoking gun. The test we conducted ... demonstrates that this (foam debris) is in fact the most probable cause creating the breach that led to the accident of the Columbia and the loss of the crew and vehicle.”  
*S. Hubbard, Columbia Accident Investigation Board (CAIB) member, July 7, 2003*



## Crater Simulation Analysis

“... the debris assessment team used the Crater software developed by Boeing Co. engineers. Crater is normally intended for prelaunch predictions about how small debris, usually ice, could damage the shuttle's external tank. The software is also used postlaunch to analyze divots in the shuttle's exterior tiles.” *R. Edwards, FCW.com, September 8, 2003*

(Boeing) “gave their findings to NASA on Jan. 23. Within the report, however, were uncertainties raised by the program: the foam could potentially cut a gouge deeper than the thickness of tile, though the report assured NASA that Crater was ‘conservative,’ that is, it tended to overestimate damage. The report emphasized the view that the tile would survive, and the engineers suggested that a more dense layer at the base of each tile would further blunt the effect of the foam. The mission management team quickly accepted the analysis the next day and moved on.” *J. Schwartz, New York Times, August 25, 2003*

“The use of Crater in this new and very different situation compromised NASA's ability to accurately predict debris damage in ways that Debris Assessment Team engineers did not full comprehend.” *CAIB Report, August 2003*

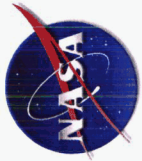
## Relevant CAIB Findings

**F6.3-11** Crater initially predicted tile damage deeper than the actual tile depth, but engineers used their judgment to conclude that damage would not penetrate the densified layer of tile. Similarly, RCC damage conclusions were based primarily on judgment and experience rather than analysis.

**F6.3-18** After Program managers learned about the foam strike, their belief that it would not be a problem was confirmed (early, and without analysis) by a trusted expert who was readily accessible and spoke from “experience.” No one in management questioned this conclusion.

“In the beginning, we thought that NASA had made a Type II error using an unvalidated simulation, but found that they had made a Type I error instead.”

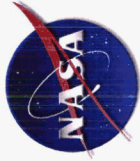




## ***VV&A Implementation Conclusions***



- Because the VV&A effort consists of a managed risk-based set of processes, there is no necessity for an up-front, all-or-nothing, go/no-go decision; crawl, walk, run.
- Early inclusion of VV&A in conjunction with a well disciplined M&S development /integration effort will add a smaller overall delta cost.
- Robust implementation will facilitate M&S reuse (longer-term dollar cost savings) in conjunction with follow-on, out-year development efforts.
- VV&A implementation coincident with the M&S development will help instill good Configuration Management practices.
- VV&A implementation is congruent with the in-process transition to a more disciplined NASA culture

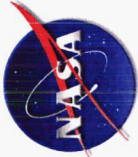


# ***VV&A Approach Summary***



- The proposed VV&A Policy and implementation approach is based on the Defense Modeling and Simulation Office (DMSO) VV&A Recommended Practices Guide (RPG).
- The Accreditation process is proposed to be guided by the Joint Accreditation Support Agency (JASA) and documented in an Accreditation Support Package (ASP).
- The VV&A implementation approach will be tailorable, with multiple levels of VV&A.
- The extent of the VV&A application will take into account:
  - the assessed level of risk associated with the M&S use,
  - the criticality of the simulation results to the decision being reached, and
  - the availability of time, money, and personnel to execute the V&VA efforts.

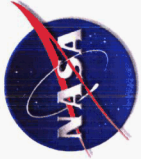




# Current VV&A Challenges



- 1) **VV&A program implementation needs to be anchored to an ESMD-level endorsed VV&A Policy in order to progress.**
- 2) The degree of ESMD-envisioned government/contractor collaboration needs to be determined to establish intra-organization expectations.
- 3) The extent to which applicable (S/W development & CM/DM) standards have been / will be incorporated into the CEV RFP needs to be determined (can facilitate VV&A activities).
- 4) The Risk Management Plans, CM/DM Plans and the VV&A Policy/Procedures need to reflect a common perspective to ensure program coherence.
- 5) The VV&A implementation timeline will have to be aligned to the available systems development (i.e., analysis plans) timeline.
- 6) The DMSO/JASA experience base confirms that the magnitude of the VV&A effort is significant, especially for legacy M&S.
  - NASA has a large number of Models and Simulations that have not been through a VV&A process.
- 7) To what extent is the Program willing to implement and administer an Analyst Certification activity?
- 8) Other ...

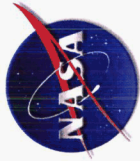


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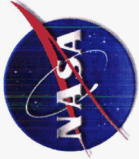




# Integrated Modeling and Simulation



NASA Software/Systems Documentation	DoD M&S/VV&A Documentation	NASA M&S VV&A Documentation
NPR 7120.5B NPR 7150.2 NPR 8000.4 NASA-STD-8739.8 NPD 2820.1A NPD 8730.4A NASA-STD-8719.13	DoDD 5000.1 DoD 5000.2-R DoDI 5000.2 DoDI 5000.59 DoDD 5000.61 DMSO RPG JASA ASP Army DTC Pam 73-4 AR 5-11 DA Pam 5-11 Navy SECNAVINST 5200.38A M&S Impl Hnbk SECNAVINST 5200.40 VV&A Best Practices AF AFI 16-1001 AFPD 16-10	In development

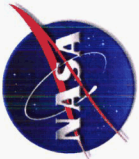


# ***IM&S Roadmap***



- Overall, there is a perceived need for stronger NASA M&S Policy guidance and subsequent capability implementation that addresses: requirements generation, development, VV&A, configuration management and life-cycle management
  - NASA (ESMD?) Policy on the use of M&S in the development process
    - An NASA Policy that champions the use of M&S for development support
    - Advocacy for M&S use in conjunction with Verification Test and Evaluation activity
    - Need technical and procedural standards to guide development and use of M&S
  - NASA (ESMD?) M&S Management Policy
    - Strategic direction to prioritize and integrate M&S requirements
    - Oversight, coordination, and communication
    - Use of a M&S Master Plan
    - Use of a M&S Investment Plan
  - Data and data administration for M&S applications

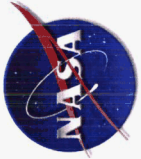




## ***IM&S Roadmap (Cont'd)***



- **NASA (ESMD?) VV&A Policy**
  - Criteria for conducting VV&A activities
  - Designation, authority and defined responsibilities for conducting VV&A
  - Need for established procedures to ensure VV&A activity accountability and responsibilities are upheld
  - VV&A Procedures
- **NASA (ESMD?) M&S Development Policy (Use of Standards; i.e., HLA)**
  - SEI/CMM Level 3 for software development (this will address the type of documentation to be produced in M&S development)
  - Use of development Standards (i.e., system engineering standards (IEEE, Mil-STD, etc.))
- **NASA (ESMD?) Policy on M&S Configuration Management**

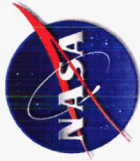


# Organizational Challenges



- Institutional awareness of and advocacy for Integrated M&S requirements and their extensive use for senior manager decision-making needs to be improved
- Greater organizational stability is needed to improve traction to effect an Integrated M&S approach
- There is a need for centralized M&S management and control to ensure integration / interoperability and re-use capabilities
- An overarching Integrated M&S (and integral VV&A) Policy will be “new” to the ESMD and NASA at large, so deployment / rollout / compliance tracking will be a formidable task
- NASA has a large bow-wave of legacy Models and Simulations that will need to be VV&A’ed
  - V&V work has been accomplished in the past, but inconsistently applied within the NASA’s Centers
  - The V&V work that has been applied has been accomplished in an inconsistent manner across those Centers
  - Organizing and vetting the existing V&V substantiating documentation will pose a large workload
  - NEXIOM) Data Model adaptations / wrapping changes to “all” existing M&S has significant VV&A implications

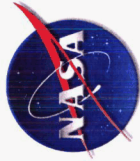




# ***Integrated Modeling and Simulation Recommendations***

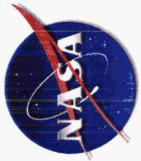


- **Start Now (Regardless of Organizational Turmoil)**
  - Establish the Champion in HQ (ESMD?, SE&I?) who will act as the Policy advocate for:
    - M&S Development
    - M&S Use
    - M&S VV&A
    - M&S Configuration Management
    - Training/experience of analysts that use M&S
- **Develop a comprehensive Integrated M&S Program Plan**
  - Identify planned M&S use in support of reviews, KDPs and other decision-making events
  - Establish a M&S Budget
  - Establish an M&S implementation Schedule
  - Prioritize VV&A activities based on risk level and need dates (Managed Investment)
  - Conduct risk assessments on all M&S that supports major decision-making events
  - Get Assistance from a VV&A Support Contractor



# Backups





# The Vision for Space Exploration - National Benefits Key Role of Innovation and Technology...

- Background

- “...U.S. achievements in space...have led to the development of technologies that have widespread applications to address problems on Earth...

- “In preparation for future human exploration, we must advance our ability to live and work safely in space and, at the same time develop the technologies to extend humanity’s reach to the Moon, Mars and beyond. The new technologies required for further space exploration also will improve the Nation’s other space activities and may provide applications that could be used to address problems on Earth.”

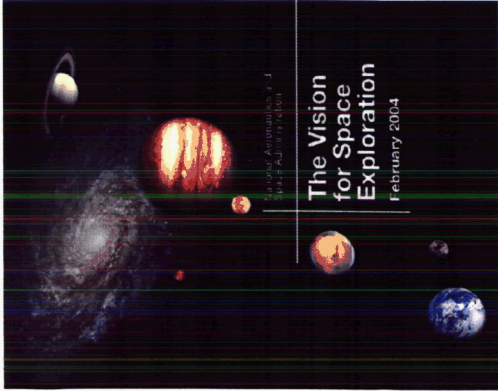
- Policy Objective (Technology)

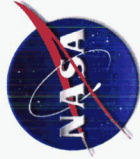
- “Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration...

- National Benefits (Technology)

- “Preparing for exploration and research accelerates the development of technologies that are important to the economy and national security. The space missions in this plan require advanced systems and capabilities that will accelerate the development of many critical technologies, including power, computing, nanotechnology, biotechnology, communications, networking, robotics, and materials.”

- “These technologies underpin and advance the U.S. economy and help ensure national security. NASA plans to work with other government agencies and the private sector to develop space systems that can address national and commercial needs.”



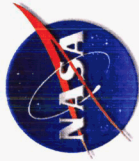


# The Nation's Vision



1. Return the Shuttle to safe flight as soon as practical, based on CAIB recommendations
2. Use Shuttle to complete ISS assembly
3. Retire the Shuttle after assembly complete (2010 target)
4. *Focus ISS research to support exploration goals; understanding space environment and countermeasures*
5. Meet foreign commitments
6. *Undertake lunar exploration to support sustained human and robotic exploration of Mars and beyond*
7. *Series of robotic missions to Moon by 2008 to prepare for human exploration*
8. *Expedition to lunar surface as early as 2015 but no later than 2020*
9. *Use lunar activities to further science, and test approaches (including lunar resources) for exploration to Mars & beyond*
10. *Conduct robotic exploration of Mars to prepare for future expedition*
11. *Conduct robotic exploration across solar system to search for life, understand history of universe, search for resources*
12. *Conduct advanced telescope searches for habitable environments around other stars*
13. *Demonstrate power, propulsion, life support capabilities for long duration, more distant human and robotic missions*
14. *Conduct human expeditions to Mars after acquiring adequate knowledge and capability demonstrations*
15. *Develop a new Crew Exploration Vehicle; flight test before end of decade; human exploration capability by 2014*
16. *Separate cargo from crew as soon as practical to support ISS; acquire crew transport to ISS after Shuttle retirement*
17. Pursue international participation
18. Pursue commercial opportunity for transportation and other services

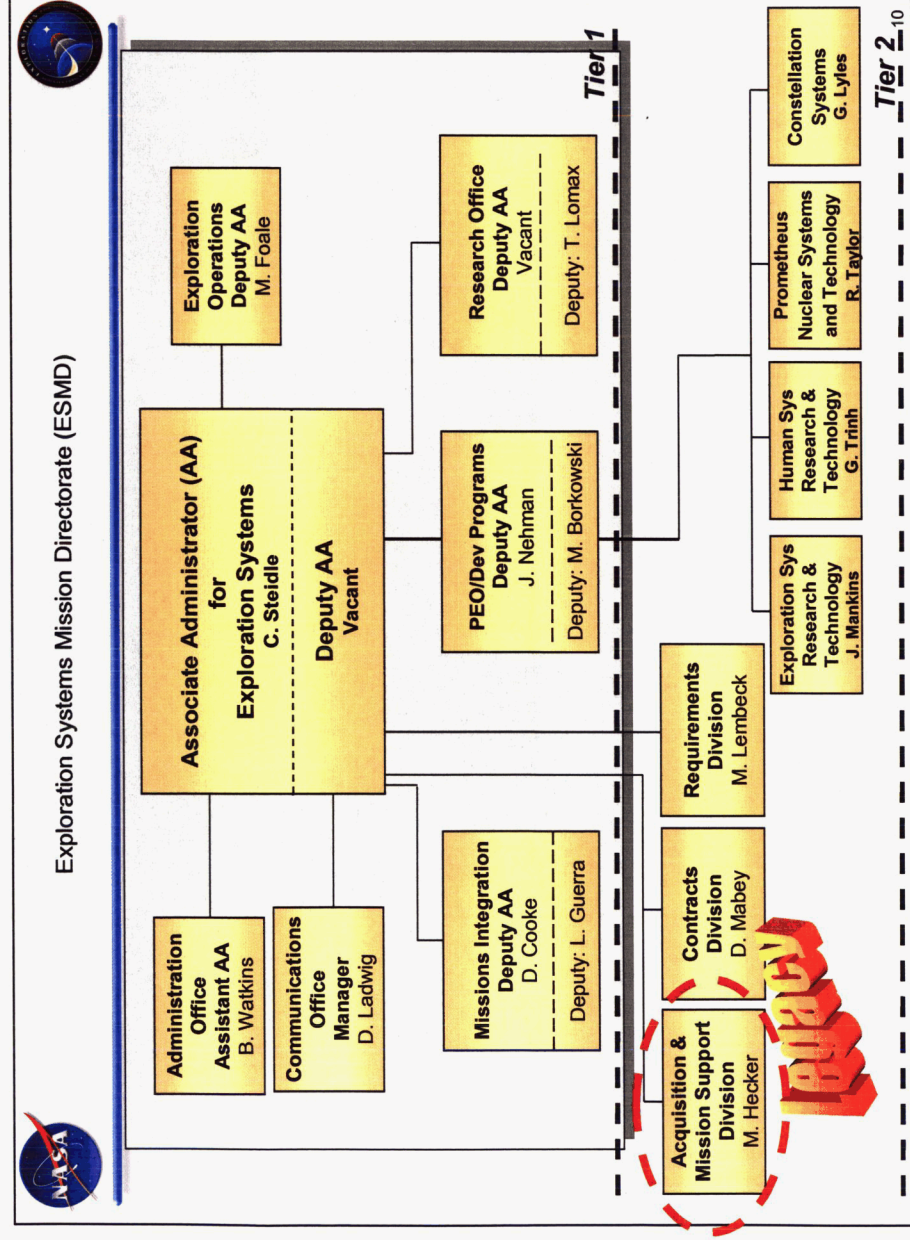


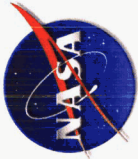


# Simulation Based Acquisition (SBA) Status – 3-16-2005

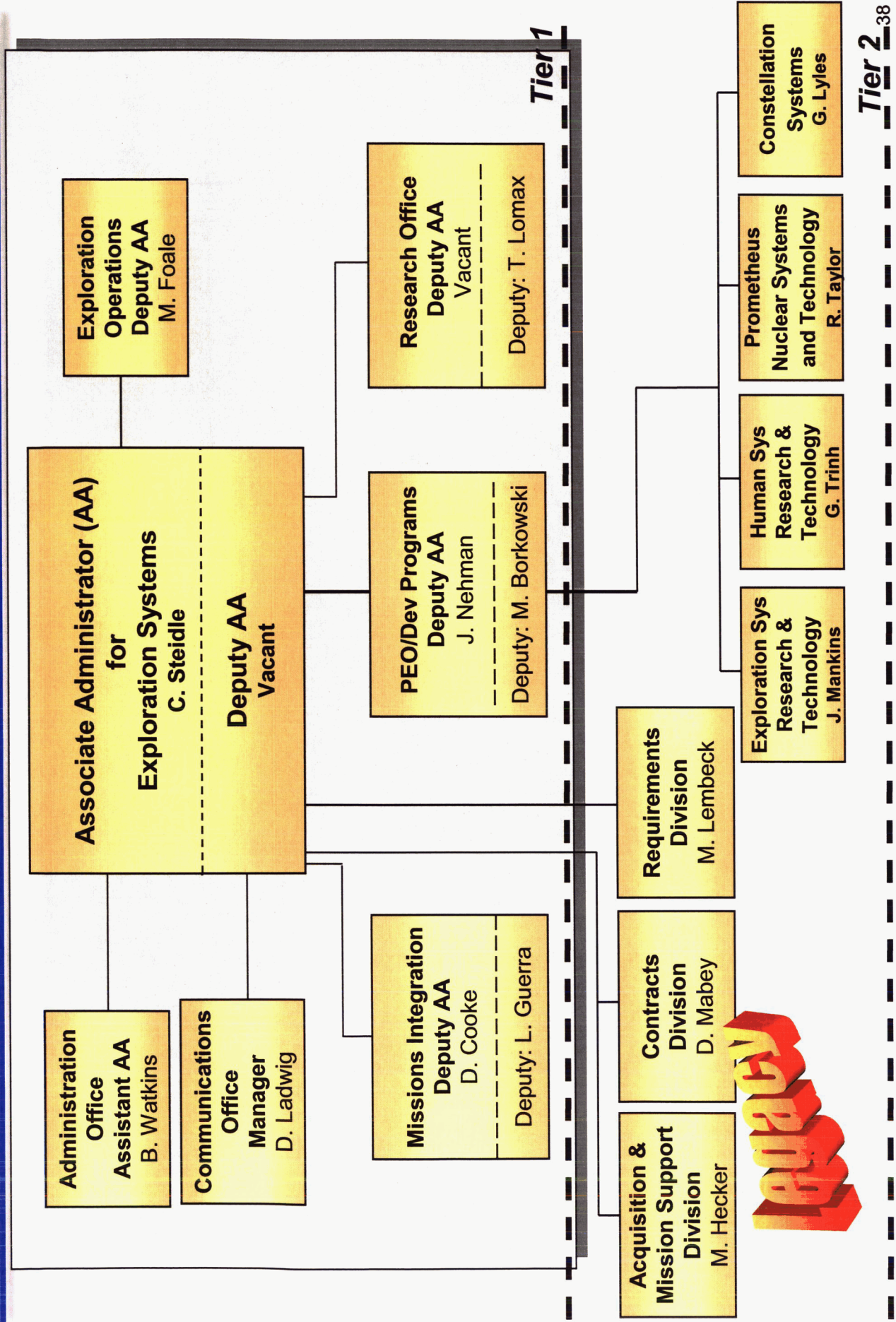


The Chief Information Office (CIO) and the Simulation Based Acquisition (SBA) Support Office were merged into one entity (CIO) in the ESMD Acquisition and Mission Support Division

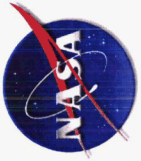




# Exploration Systems Mission Directorate (ESMD)





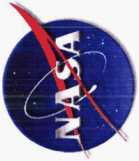


# ***Integrated Modeling and Simulation Lessons Learned***



**M&S credibility is built on 6 (or more?) foundational elements**

- **Quality of the M&S development program**
  - **Capability Maturity Model Level III**
  - **Standards**
- **The Conceptual Model**
  - **Quality of the abstraction**
- **VV&A**
  - **Capability, Accuracy, Correctness, Usability**
  - **Consistent Process**
  - **Federations present significant challenges**
- **Configuration Management**
  - **Drives software trouble reports**
  - **Controls changes to the M&S**

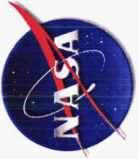


# ***Integrated Modeling and Simulation Lessons Learned (Cont'd)***



- **Documentation**
  - Provides sources for establishing credibility
  - Analyst/Users manuals
  - Developers manuals
  - Programmer's manual
  - Configuration Management histories/logs
  - Software design documentation
  - Documented set of requirements and Conceptual Model
  - Software Development Plans
- **Usage history**
  - Long-term successful use is evidence of M&S that represents the real world

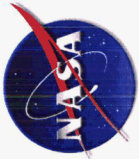




## So Why Do VV&A?



**Establish a clear understanding  
of the respective strengths and weaknesses  
of each Model and Simulation to be used  
and the bounds within which  
that Model's / Simulation's,  
(*and it's associated output data*),  
application is credible.**

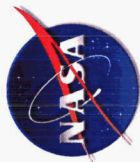


# Overarching VV&A Realities



- VV&A implementation presents a significant challenge (*Defense Modeling and Simulation Office (DMSO) and Joint Accreditation Support Agency (JASA)*)
- The State-of-the Art for Validation and Accreditation are not perfected (*DMSO Roadmap and DMSO Status Report, Plenary Session, Foundations '04*)
- Historical M&S development and application cost data are not readily available within acquisition programs (*Estimating V&V Resource Requirements and Schedule Impact, Foundations '02, p 6*)
- However, despite these realities ...





# User Impact - Patriot (Test & Evaluation application)



## CNN.com™

### Pilots dead after Patriot accident

Sunday, March 23, 2003

DOHA, Qatar (CNN)

-- The pilot and co-pilot aboard the British Tornado GR4 aircraft that was shot down by a U.S. Patriot missile are dead, London's Defense Ministry has said.



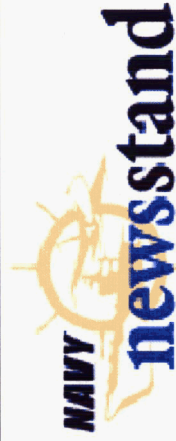
(AP FILE)

A British Tornado GR4 similar to the one shot down

**One cause of these failures stemmed from using an invalid simulation to stimulate the Patriot's fire control system during its testing.**

*S. Hoffman, NAWC-PMTR, NAVMSMO VV&A TST Meeting*

**During Operation Iraqi Freedom, Patriot missiles shot down two allied aircraft & targeted another.**



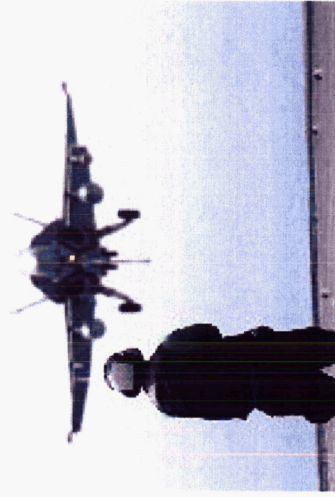
### Patriot Missile Possible Cause in Loss of Hornet

Story Number: NNS030404-02

Release Date: 4/4/2003 9:10:00 AM

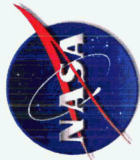
From U.S. Central Command Public Affairs

CAMP DOHA, Kuwait (NNS) -- A Patriot missile may have downed the U.S. Navy F/A-18C Hornet which was flying a mission over Central Iraq at approximately 11:30 p.m. (3:30 p.m. EST) April 2. The circumstances of the incident are under investigation.



A flight deck worker watches as an F/A-18C Hornet comes in for a landing on the flight deck aboard USS Constellation (CV-64)





# User Impact - MV-22 Osprey Tiltrotor (Training application)



**CNN.com**

**Marine Corps aircraft crashes in Arizona, killing 19**

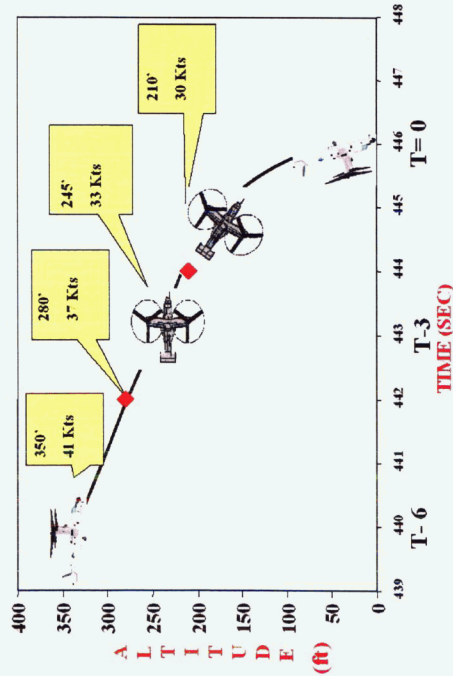
April 9, 2000

MARANA, Arizona (CNN) -- An experimental Marine Corps aircraft crashed in flames during a training mission in Arizona Saturday night, killing everyone on board, authorities said.



(CNN)

Last 6 seconds of flight



Armed Forces Information Service, June 20, 2004

"During this maneuver, the pilot dropped his speed to near 40 knots and experienced 'vortex ring state (VRS),' a rotor stall that results in a loss of lift. Attempts to recover worsened the situation and the aircraft crashed," McCorkle said.

"Increased use of simulators proposed to reduce need for manned flights."

"To meet the unique training requirements for the MV-22, pilots will practice flight operations within the simulator that encompass normal and emergency procedures; visual, instrument and night vision goggle flight; formation flight; aerial refueling; and takeoffs and landings from ships, airfields and confined area landing sites."

Raytheon Press Release, 1 April 1999

"Maj. Brow (the pilot) had ... 100 hours in the Osprey simulator versus nearly 3,800 hours of total flight time. However, none of his training or experience involved coping with a vortex ring."

Defense Daily, 26(10), 19 May 2000

"Power settling can occur while in the helicopter mode. Marine brass reluctantly admitted that during the mandatory 65 hours of training on flight simulators, pilots received no power settling (i.e., VRS) training."

J. Stryker Meyer, North County Times, December 31, 2000

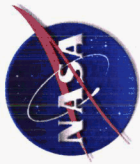
**"Accuracy of simulated flight tests questioned."**

"Navy INSURV readiness for OPEVAL report, and OPTEVFOR's V-22 OPEVAL report"

**"The flight simulator did not replicate this (VRS) loss of controlled flight regime."**

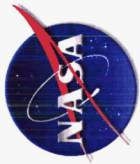
"General Accounting Office, Presentation to the V-22 Blue Ribbon Panel, January 12, 2001"





## ***Subsequent Briefing Material***

- **Provided: Process Development Background**
- **Identified: NASA VV&A Policy Development Interfaces - Primary POC / Agencies / Topics**
- **Recommended: VV&A Policy**
- **Provided: DMSO Recommended Practices Guide VV&A Definitions**
- **Addressed: “Building” a VV&A-Compliant Model/Simulation**
- **Posed: the Conundrum - How does one Validate and Accredit M&S with little or no Real World data? {Use a Validation Process Maturity Model approach}**
- **Addressed: a “Notional” VV&A Implementation Timeline**
- **Provided: a NASA M&S VV&A Process Overview**
- **Explained: Accreditation Report Options**
- **Outlined: VV&A Process Interaction with NASA M&S Lifecycle**
- **Proposed: a NASA M&S VV&A Process for Constellation Systems**
- **Summarized: with a VV&A Presentation Wrap-up**

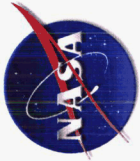


# ***IM&S for Decision-making***



- **Fundamental premises:**
  - **IM&S improves the acquisition process by reducing cost, enhancing verification, test, and evaluation and shortening development time for new systems**
  - **IM&S allows improved, more rigorous testing of systems. The ability to link early prototypes of systems into a larger, more demanding environment allows the identification of problems with systems earlier, when they are less costly to fix.**
  - **IM&S serves as a valid methodology for working many integration/interoperability problems**





## **IM&S Conclusions**



- **Models and Simulations are more than software, with unique characteristics that distinguish them from other computer software applications. Disconnects in current NASA guidance documents**
  - **The use of *Integrated* M&S to support NASA's development (acquisition) process has not been robustly evident**
    - **No requirement to use M&S to support system acquisition**
    - **No specific controls on use of M&S**
- **Criteria for conducting Independent Verification and Validation (IV&V) is not clear nor consistent with needs—most M&S is classified as Class D or lower software (NPR 7150) and IV&V is optional or not required.**